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AUTHOR White, Barbara
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ABSTRACT

During the past 10 years, the field of industrial arts, stimulated by rapid technological changes, has changed its name and its focus to technology education. Industrial arts goals chronicled from the 1920s to the present indicate an increased emphasis on the study of industry and technology, critical consumerism, and the development of intellectual processes and interpersonal behavioral skills. A study of these changes by 20-year increments reveals how the discipline has changed from one that emphasized problem solving for a particular project to one that requires the application of problem-solving skills to global situations. Although there is still considerable disagreement among teachers, teacher educators, and technologists regarding what should be the content of technology education programs, a great number of content designs expand on the four technical systems of communication, transportation, manufacturing, and construction identified in the Jackson's Mill Industrial Arts Curriculum Theory document (1981). Some exemplary programs have gained the national spotlight. Some are statewide (New York, Virginia, Illinois); some are limited to specific areas within a state, and some are school-specific. The best programs are those in which problem-solving and critical thinking experiences are provided for students. For teachers, this is a time for renewed professional commitment and growth to ensure that the technology education program takes its rightful place in the curriculum. (KC)

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Technology Education: Industrial Arts in Transition

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Technology Education: Industrial Arts in Transition

Barbara White

Office of the State Director for Vocational Education
State Board for Vocational Education, University of Hawaii
Honolulu, Hawaii

February, 1990

Preface

Industrial arts instructors are witnessing a dynamic era in their profession. Leaders in the field have come face-to-face with the increasing importance of graduating technologically literate students and have determined that this responsibility should be a primary concern of industrial arts education.

In response, industrial arts professional organizations have changed their names to include technology education; state-level curriculum guides throughout the nation have been modified; teacher educators have introduced new pedagogy; and individual industrial arts instructors have developed technology education curriculum. The profession has examined its philosophy and its goals and tried to respond to the changing needs of society.

Such profound change does not occur without turmoil and discontent. In fact, there are those who contend that industrial arts/technology education is in a crisis.

This document examines the changing goals of industrial arts from the 1920s through the 1980s and presents a discussion on the current and emergent paradigms of industrial arts. The document ends with a review of technology education curriculum and cites some exemplary programs, including one that is a central project (a central project is one in which a particular topic serves as the focus for the entire school).

The Office of the State Director for Vocational Education submits this document to eductors in Hawaii who are concerned with improving industrial arts education. While technology education may not be the only driving force in industrial arts, it seems to have earned an important place as a guiding force.

Table of Contents

Preface.....ii

Introduction..... 1

A Change in Goals..... 2

The 1920s..... 3

The 1940s..... 4

The 1960s..... 5

The 1980s..... 5

Current and Emerging Paradigms of Industrial Arts..... 7

Subject Matter..... 8

Theories and Models.....10

Values.....11

Methods and Instruments.....11

Exemplars.....12

Social Matrices.....13

Technology Education Curriculum.....14

Exemplary Technology Education Programs.....16

Technology Education as a Central Project: An Example.....20

Summary.....23

References.....26

List of Tables and Figures

Table 1 Evolution of Industrial Arts/Technical Education Goals.... 3

Table 2 Current and Emerging Paradigms of Industrial Arts..... 9

Figure 1 McCullough High School Central Project.....22

Introduction

During the 1980s, many educators in this country and around the world have sensed a need to address changes brought about by the rapid evolution of technology. These educators have sought to transform traditional industrial arts education to technology education, which shifts some emphasis away from the development of discrete occupational skills and places more emphasis on developing an understanding of major technological systems like manufacturing, communications, power and energy, and construction.

This major shift in the conception and purposes of industrial arts remains a hotly debated issue, but the transition to technology education continues. One significant milestone in this transition occurred when the American Industrial Arts Association (AIAA) changed its name to the International Technology Education Association (ITEA). In addition, many state associations have also changed their names to include technology education and the American Industrial Arts Student Association (AIASA) has renamed itself the Technology Student Association (TSA). More recently, the Industrial Arts Education Division of the American Vocational Association changed its name to the Technology Education Division.

As important as these name changes are, industrial arts will not be technology education until the underlying philosophical differences between industrial arts and technology education are understood and accepted by instructors. In fact, Clark (1989, p. 7) believes that "many efforts in the movement toward technology education have failed because changes have been made in name only."

This document examines the shift in industrial arts goals and subsequent curriculum changes and describes some programs which have successfully made the transition from industrial arts to technology education.

A Change in Goals

The goals of industrial arts in the beginning of this century were more restricted and less varied than recent goal statements referring to technology education. Early industrial arts goals included statements about career exploration and vocation, consumerism, and skill development and heavily emphasized the purpose of the subject matter as prevocational study. In contrast, recent technology education goals reflect an increased emphasis on the study of industry and technology, critical consumerism, and the development of intellectual processes and interpersonal behavioral skills.

It is interesting to note that the term "technology" was used in Hawaii industrial arts curriculum guides as early as 1965 in order to give the field a broader perspective and to include the study of concepts. For example, in 1965 the curriculum guide for Automotive Mechanics was retitled Automotive Technology and included the concept of "power."

The evolution of industrial arts/technology education goals can be illustrated in 20-year increments as shown on Table 1. A more detailed explanation of the shifting goals of industrial arts/ technology education in these 20-year spans follows this table.

Table 1
Evolution of Industrial Arts/Technical Education Goals

Categories of Goals	Twenty-Year Time Periods			
	1928	1948	1967	1980s
Physical Development	X			
Integration of Disciplines		X		
Intellectual Processes		X	X	X
Career and Vocation	X	X	X	X
Critical Consumerism	X	X	X	X
Skills Development	X	X	X	X
Industry and Technology			X	X

The 1920s

A 1928 study about the goals of industrial arts reflects a traditional view of industrial arts highlighting career exploration and vocational, consumer, and skill development (Zuga, 1989). The vestiges of Woodwards's 1898 Manual Training in Education are evident in the goal of developing fine motor control. Some of the goals were as follows:

Career Exploration and Vocation: provide exploratory shop and drawing courses for the detection, discovery, or tryout of interests and aptitudes; avocational and prevocational purposes, preparing for a future industrial occupation;

Critical Consumerism: make more intelligent choosers and users of the products of industry;

Skill Development: develop household mechanics, develop mechanical intelligence through experience in hand work where fairly high levels of skill in the use of various tools and materials are the chief emphasis;

Physical Development: develop coordination of "hand and eye" by making things.

The 1940s

By 1948, the concern for developing motor control was dropped as a goal, but the major goals of career exploration and vocational, consumer, and skill development continued (Zuga, 1989). Two new goals in the intellectual processes and the integration of disciplines were added. These goals were influenced by the philosophy of the time period and reflected the earlier influence of the "Cardinal Principles" of secondary education generated by the 1937 National Education Association's Educational Policies Commission report. Industrial arts was also growing into a specifically secondary education subject and reflected the prevocational emphasis necessary in a society in which a high school diploma was the terminal educational program for a majority of its members.

Goals during this particular 20 year increment included:
Intellectual Processes: develop social understanding and the ability to work in groups; develop the ability to plan and complete projects;
Integration of the Disciplines: provide a medium for expression in mathematics, science, language arts, and social science;
Career Exploration and Vocation: give experiences that will increase understanding of modern industry and that will lay the foundation for and help determine vocational interests; avocational purposes;
Critical Consumerism: develop the ability to recognize quality and design in the products of industry;
Skill Development: use a variety of tools and construction materials in a workerlike manner; develop the ability to read and make working drawings, charts, and graphs; and develop the ability to maintain and service the common products of industry in a safe and efficient manner.

The 1960s

By the 1960's, industrial arts goals began to reflect a greater concern for the study of industry and technology while maintaining many of the previous goals. Perhaps industrial arts educators began to be influenced by the study of the disciplines movement in curriculum. Goals in industrial arts textbooks written during the 1960's emphasized the following:

Industry and Technology: explore industry and American industrial civilization;

Intellectual Processes: develop critical thinking related to industry and industrial materials; develop desirable social relationships;

Career Exploration and Vocation: provide information and experiences in order that students may choose a future vocation; develop recreational and avocational activities;

Critical Consumerism: increase appreciation for good craftswork and design; increase consumer knowledge for the purpose of selecting, buying, and using the products of industry;

Skill Development: develop safe working practices and develop a degree of skill.

The 1980s

Just as the goals of industrial arts in the 1920s reflected the influence of manual training, current goals of technology education reflect the influence of industrial arts. Even with this influence, however, a shift in the emphasis of industrial arts/technology education may be observed, according to Zuga (1989). More emphasis is being placed on the subjects of industry and technology, the teaching of cognitive and affective intellectual processes, and the role of

consumerism. Many of the goals listed in current technology education plans appear to include a greater emphasis on the relationship of industry, technology, and society. In addition, statements about the value of problem solving have changed from simple statements about the ability to plan and construct projects to more global statements about the role of problem solving in society. Zuga (1989, p. 37) claims that there is a "lack of contemporary teacher education texts about technology education goals and studies which synthesize those goals." Thus she suggests using the American Technical Foundation implementation guide as a model for current technology education goals. They include the following:

Industry and Technology: appreciate the evolution of industry and technology;

Critical Consumerism: establish values on the impact of industry and technology and how it alters our environment; develop human potential for responsible work, leisure, and citizenship roles in a technological society.

Skill Development: develop knowledge and ability to properly use the tools, techniques, and resources of industrial and technological systems;

Intellectual Processes: develop creative solutions to present and future societal problems using technical means; and

Career Exploration and Pre-Vocation: develop human potentials for responsible work, leisure, and citizenship roles in a technological society.

These goals represent what selected industrial arts/technology educators believe to be important about the subject matter. They do

not necessarily reflect the actual practice of industrial arts/ technology educators (Zuga, 1989). Just what is happening in the classroms and laboratores of technology education is, perhaps, a very different picture. Clark (1989) believes that this professional reaction (or lack thereof) accentuates the scope of the crisis in the movement toward technology education.

Current and Emerging Paradigms of Industrial Arts

Clark (1989) believes that because of the recurrence of name-change-only programs, and the fact that industrial arts teachers often do not perceive differences between industrial arts and technology education, it may be beneficial to the profession to view industrial arts as a paradigm. A paradigm, according to Kuhn (1962) denotes a universally accepted set of models and beliefs held by a community of practitioners. According to Kuhn, paradigm shifts occur when a paradigm enters a crisis-like state: "All crises begin with the blurring of a paradigm and the consequent loosening of the roles...and close with the emergence of a new candidate for paradigm and with the subsequent battle over its acceptance" (p. 84).

According to this definition, industrial arts/technology education is a paradigm in crisis. For while industrial arts teachers agree that technology should be inherent in their curriculum and while some industrial arts teachers identify technology education as what they currently teach, the unit shop remains the primary delivery method in the field (Smith, 1989). Industrial arts teachers adhere to beliefs and traditions that are firmly established in successful pedagogical methodologies which have served them well. Clark (1989)

believes that that tradition may well be what has slowed the progress to a 21st-century, technology-based paradigm.

According to Clark (1989, p. 9), "the legitimacy of the traditional industrial arts paradigm is locked in the early 1900's. Industrial arts teachers and students alike are prisoners in a content world that is so far removed from modern technology that many professionals in the field have difficulty simply justifying their existence to their general education colleagues." He proposes a new paradigm, using the six componenets believed to be essential to any paradigm (Mohrman and Lawler, 1981) to distinguish between the paradigm of industrial arts and the hypothesized new technology education paradigm.

The six components of a paradigm (subject matter, beliefs, values, methods, exemplars, and social matrices) are described in the following section to distinguish between the paradigm of industrial arts and the hypothesized new technology education paradigm. A summary of these distinctions for each of the component areas is shown in Table 2.

Subject Matter

The industrial arts curriculum is industry based even though the current curriculum reflects the technology of years past. Bennett (1937) stated that industrial arts is essentially the same as manual arts (forerunner of industrial arts), although its connotations are different. In industrial arts, the "industrial" is emphasized, whereas in manual training (forerunner to manual arts), "manual" is stressed. Clark (1989) claims that over the past 70 years, the

Table 2
Current and Emerging Paradigms of Industrial Arts*

Components of a Paradigm	Industrial Arts	Technology Education
Subject Matter	Material shops Avocational skill Serves the interest of local instructors	Human-adaptive systems: manufacturing, transportation, communication, construction Developmental skills for all students Experimental approach to concepts/content Integrated knowledge
Theories and Models	Late 19th century/early 20th century industry Teachers impart knowledge Product emphasized Step-by-step methods Drill and practice	Problem solving Critical thinking Process emphasized Supports total curriculum Trial and error
Values	Individualized instruction Survival skills Leisure-time skills Hands-on Alternate track for academically less able, less willing	Individualized instruction and performance Cooperative learning Action based/hands-on Applications of technology
Methods and Instruments	Domain-referenced testing Psychomotor skill development Individual predesigned projects	Group problem solving Individual problem solving Generalizable skills Total domain learning: cognitive, affective, psychomotor Scientific inquiry
Exemplars	Unit shops Locally developed programs Vocational or prevocational education Survival skills	Today's technology Transferable knowledge Unified mission
Social Matrices	AIAA, state and local divisions Armchair curriculum development School Shop Project fairs	ITEA, state and local divisions The Technology Teacher ITEA: Stanley/Proto mass-production competition Advisory committees Technology-based student organizations Science/technology fairs ITEA: technology fairs

NOTE: The designation of the six components of a paradigm was abstracted from Lawler (1981). Some signifiers were developed by Pratzner (1985).
*Clark, 1989, p.10.

subject matter in industrial arts classrooms and laboratories has undergone little change. The philosophy of teaching the tools, processes, and materials of industry has served the existing paradigm well.

Rudnick (1985) believes that the emerging paradigm of technology education, which is the alternative to industrial arts education, eliminates the dedication to special interest groups and moves back into the general education curriculm with a program designed to serve the needs of all students--a general education course dealing with an understanding of today's technological society. The new paradigm of technology education is composed of the four human-adaptive systems of subject matter that embody the four major areas of contemporary society. These are manufacturing, transportation, communication, and construction. The content areas of the new paradigm can be based in society as well as industry and do not create specialists in any field within either realm. Understanding the social implications of work and change and developing problem-solving and critical-thinking skills are but a few of the major goals of the technology education paradigm.

Theories and Models

According to Clark (1989, p. 12), the paradigm of industrial arts is based on the labor-intensive model of industry that existed at the time of the industrial revolution in America. Content is determined from a trade and job analysis of selected occupations such as cabinetmaking, drafting, or welding.

In contrast, the models and theoretical genesis of the technology education paradigm are derived from the ways human beings

adapt to contemporary technological society (Savage, 1989). The major concerns in a technology education program lie with problem-solving and critical-thinking skills, futuristic thinking, adaptability, and application of general skills for a productive life (ITEA, 1985). These broad areas can be covered in the total school curriculum because technology is the thread that runs through all subjects and affects all people. That integration of curriculum stands at the core of technology education for all students (Maley, 1985).

Values

Critics of the industrial arts paradigm claim that the valued curriculum in this model is a continuum from developmental shop work to advanced shop work. This progression from basic shop work to vocational work was criticized as early as 1923 (Sanders, 1989). The new technology education paradigm, in contrast and according to its proponents, is based on solid educational goals--problem solving, sensitive human relations, self-understanding, and the integration of one's total experience into an educational system that aims toward self-renewal and lifelong learning (Clark, 1989). The emerging technology education paradigm seeks to advance beyond the philosophy of industry as content and to instill in students the developmental skills they will need, regardless of their vocational aspirations.

Methods and Instruments

The most unifying feature of the industrial arts paradigm, according to Clark (1989), is the unit shop within junior and senior

high schools. The tools and equipment common to hand and machine working of a specific material can be found in these unit shops. Wood shops, metal shops, and drafting rooms all represent common unit shops that have existed since the late 1800's. Thus the methods of instruction and evaluation in the industrial arts paradigm tend to be psychomotor skill development and domain-referenced testing. The skills inherent in the material with which students work dictate the range in the domain for which testing is done. The hands-on techniques for developing psychomotor skills are generic to both the existing and the emerging paradigms. The philosophy and mission behind the processes in the technology education paradigm make it vastly different from the industrial arts paradigm. In the technology education paradigm, major program goals involve generalization of problem-solving and critical-thinking skills. In technology education, skill development in all domains of learning (cognitive, affective, and psychomotor) is stressed. These skills are fostered through both group and individual-learning activities within a core curriculum based on communication, construction, manufacturing, and transportation systems. According to proponents of technology education, this configuration allows students to excel in many areas and makes the curriculum relevant to <u>all</u> students, regardless of their academic goals.

Exemplars

Exemplars are specific identifiable traits common to the paradigm. The exemplars of industrial arts are the existence and perpetuation of the unit shop and inconsistency in the curriculum

(Rudnick, 1985). Pratzner (1985) claims that the industrial arts paradigm is an alternative to the exisiting paradigm of vocational education. According to Clark (1989), exemplars of the technology education paradigm can be found in the engineering departments of business or industry with people working together on a collective charge in which each participant is responsible for her or his own area of expertise, while understanding conceptually the contribution each member is making. Thus the technology education paradigm encourages teamwork while using knowledge and processes that are common in today's society and technology. Students individually develop strategies to accept the inevitable changes taking place outside the classroom.

Social Matrices

Kuhn (1962) claims that paradigms cannot exist without the support of a group of adherents or a social network that adopts the ideas and practices of the profession. Articulation of ideas through both social and professional networks strengthens and supports the exemplars of a paradigm. Since the late 1800's, the existing paradigm of industrial arts has gained numerous supporters from both industry and education. The American Industrial Arts Association (AIAA) was the professional organization that represented the paradigm of industrial arts. The AIAA held national and regional conferences, seeking to solidify and support teachers of the many industrial arts content areas. The other national network for the industrial arts profession was the Industrial Arts Division of the American Vocational Association.

The social matrices that support the new technology education paradigm are emerging and becoming more predominant. The AIAA renamed itself the International Technology Education Association in February, 1985. Recently, the Industrial Arts Division of the AVA program changed its name to the Technology Education Division. The strength of the social matrices and methods used to support and deliver the new paradigm shows that professional attitudes are changing.

Technology Education Curriculum

According to McCrory (1987), curriculum research studies are the greatest indication of the transition from industrial arts to technology education. He found that between 1980 and 1986, the industrial arts profession underwent a significant reconceptualization of its curriculum structure.

The changing nature of technology has influenced curriculum thinking, leading to the development of new technology-based programs. The Jackson's Mill Industrial Arts Curriculum Theory document (Snyder and Hales, 1981) had a far-reaching influence on curriculum revision in the 1980s and will likely do so for some time to come. The document was prepared by 21 selected curriculum leaders in industrial arts and technology education who convened for the purpose of reconciling divergent opinions about whether industry or technology should be the major source of curriculum content. The resulting document drew upon conceptions of society and culture (human adaptive systems) and the domains of knowledge and identified four major curriculum content categories: manufacturing systems, construction systems, communication systems, and transportation systems. Although

there have been other papers written by leaders in the field which argue whether industry or technology, (Wright, 1982; Meyers, 1985; Ritz, 1981) history of technology (Maley, 1983), or a systems model (Hacker and Barden, 1983) should be the content base for technology education; the Jackson's Mill model was swiftly adopted by many curriculum theorists and developers (McCrory, 1987). Consequently a number of content designs expanding on the four technical systems of communication, transportation, manufacturing, and construction identified in the Jackson's Mill model have been developed. There is still considerable disagreement among teachers, teacher educators, and technologists regarding what should be the content of technology education programs (Sanders, 1984).

As new curriculum models began to emerge, the International Technology Education Association (1985) published a guide for program implementation that summarized rationale, goals, and courses and showcased exemplary school programs where new technology education programs were being implemented. Likewise, the National Association of Secondary School Principals (NASSP) published two special curriculum reports with similar information (McCrory and Bame, 1986; NASSP, 1985). The American Council on Industrial Arts Teacher Education's (ACIATE) 35th yearbook (Jones and Wright, 1986) included chapters focusing on implementing technology education programs at various levels, kindergarten through graduate school. ACIATE (1979) published abstracts of 26 curriculum development activities at the college level, and the American Council for Elementary School Industrial Arts published two monographs detailing suggestions for program development and implementation of industrial arts in the

elementary school (Hoots, 1980; White, 1980). McCrory (1987) analyzed a sample of these guides and found many similarities, with some appearing to be only slight modifications of those developed in neighboring states or districts. He recommends that those interested in locating curriculum guides consult a directory of curriculum guides published in the International Technology Education Association (1985) or the Sredl and Everett (1981) review of state-level comprehensive planning guides. Dugger (1988) agrees that many states have or are in the process of adopting (or adapting) their own organized set of theoretical constructs or principles for technology education. He recommends the following as good examples:

New York Futuring Project in Technology Education (1983)

Illinois Plan for Industrial Education (1983)

Iowa High School Industrial Technology Curriculum Project, 1986)

Montana Planning Guide for Industrial Education/Technology Programs (1985)

Report of the Commission on Technology Education for the State of New Jersey (1987)

Technology Education Curriculum, K-12 for Virginia (1988)

Exemplary Technology Education Programs

The enormous amount of curriculum development and research indicates an intense desire to create excellence in technology education, or, if preferred, industrial arts. In the process of trying to encourage advancements in programs one of the thrusts has been to identify exemplary practices and hold them up as examples. Zuga and Bjorkquist (1989) caution, however, that many of these models

are of the content to be taught or the "high" technology to be used with little or no attention given to the methods of instruction. Technology education may be appealing to many who are fixated by the mechanization of modern life and a course which gives the outward appearance of being advanced subject matter within the schools. Wide-belt sanders have been replaced by computers with more megabytes as rewards for doing what is right as a teacher. It is a rare person who has escaped these "symbols of success" according to Zuga and Bjorkquist (1989, p. 69). They argue that the newest technology available does not lead to the best instruction in technology education and it does not result in the achievement of the primary purpose of the field. "In many instances, flashy equipment has been used to camouflage inferior teaching" (Zuga and Bjorkquist, 1989, p. 70).

Students manipulating robots in exercises that are tightly described by the teacher does not necessarily develop technologically literate people. At the same time, some teachers of woodworking, metalworking, crafts, or drafting are teaching students how to solve problems that they have identified, how to develop methods for study, and how to evaluate alternative outcomes in systematic fashion--technologically literate people. Traditional course work can provide problem-solving experiences and contempory course work can negate critical thinking and problem solving. Thus, the specific content of the course becomes a secondary issue; the activities provided for the students become the primary issue. With these cautions in mind, two "exemplary" programs identified by the Southeast Curriculum Coordination Center (Communique, 1989) are described:

Tennessee: Preparing Technology Education Students for the Year 2000. After three Metro Nashville technology education teachers attended an Introduction to Technology workshop in an effort to learn current trends in hands-on modular instruction in their field, they decided they needed a curriclum upon which to structure their classes. Thus began the development of a curriculum for a modular Introduction to Technology class for middle school students.

The locally-inspired curriculum consists of self-directed activities for 15 modules: aerospace, applied physics, audio/video, automotive power, desk-top publishing, computer numerical control, electronics, engineering structures, future technology, gas engines, graphic communications, printing, production, research and design, and robotics. A model in TSA (Technology Student Association) is being developed.

The class consists of 20-22 students and is offered for a 12-week period, during which time each student has an opportunity to select 5 of the 15 offered modules. Students work in teams of two (and occasionally individually) in a self-directed study plan, which carries them through pre- and post-testing, vocabulary development, study questions, communications exercises, and hands-on activities. They are responsibile for keeping their records on attendance and educational progress in each module.

The program has attracted students from all categories: vocational, college bound, and special needs. As a result of taking the class, students have not only widened their horizons in the technologies of tomorrow's job markets, but they have often accomplished such basic objectives as improving reading, language arts, and mathematics skills.

Funding for equipment and construction of the modular centers comes from a variety of sources, including businesses, industries, local school systems, and federal revenues. Enrollment interest has advanced to the point that teachers are not able to offer the class to all students who are interested.

Georgia: Explorations in Technology in the Middle School. Middle school technology teachers have replaced sawhorses, sandpaper, and hammers in industrial arts laboratories with television monitors, communications equipment, robotics, and miniature rocket launch pads, signalng the future of education. Georgia now has 14 schools involved in the Explorations in Technology program.

The pilot schools redesigned the industrial arts currriculum to acquaint students with the technology they are likely to encounter in the modern workplace. The program provides students with technological experiences in communication, manufacturing, construction, and transportation. These opportunities enhance problem-solving abilities, build self-esteem, improve social skills, expand career choices, and help prepare for lifelong learning in a technological society.

Students choose between pneumatics and mechanisms in applied technology modules. Lasers may also be added for audio and visual transmissions. Computer-aided drafting and traditional drafting are offered, and there is a computer-aided lathe or mill to program designs, which the computer can then manufacture.

In a "think tank" section, students design and build balsa wood bridges to determine the strongest design. A research and design section allows students to design, build, and race balsa wood models.

Automotive systems are also featured and there is a television station with video camera and monitors. Students compare communication media by writing and producing a newscast for television and for radio, including commercials, sports, news, and weather.

Though the technology is impressive, the method of teaching is equally innovative. The projects allow hands-on experiences which hold students' interests. Students pair up and in some programs never have the same partner twice, thus developing interpersonal skills as well as mechanical knowledge.

Technology Education as a Central Project: An Example

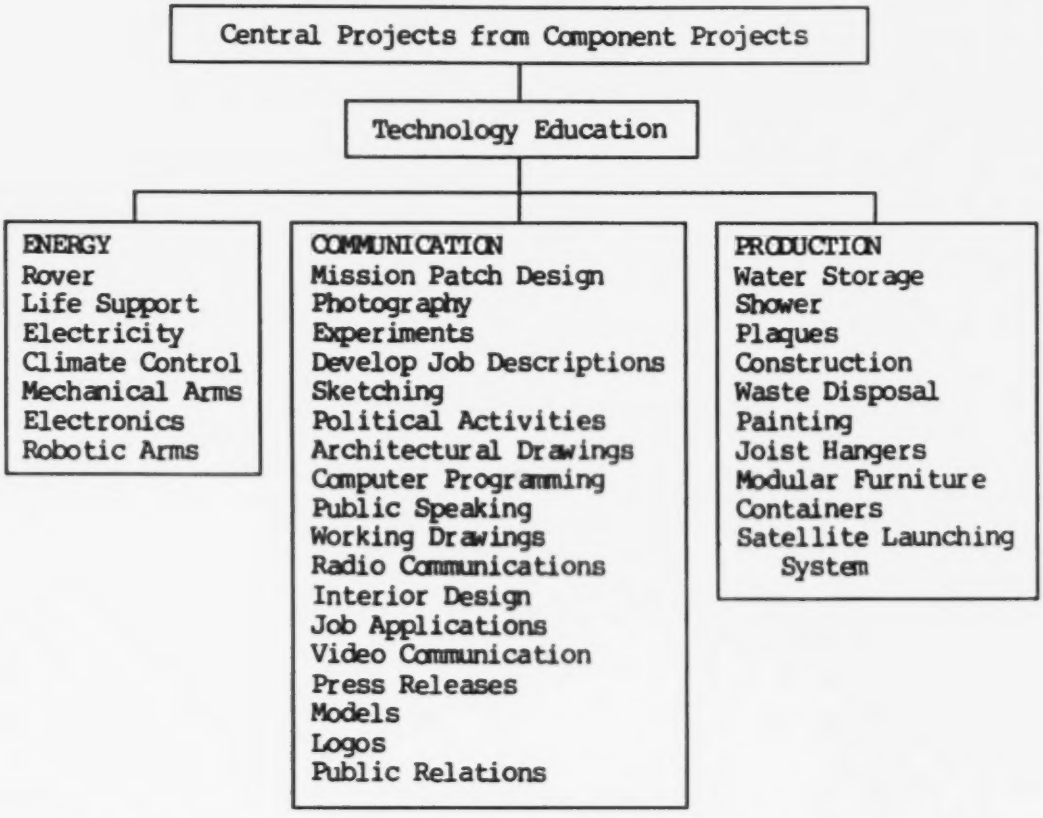
At McCullough High School in Conroe, Texas, technology education is the theme around which a central project is operated. A central project is one in which one particular topic serves as a focus for the energies of students, teachers, administrators, and the community. Teachers plan a portion of their curriculum to correspond with the central project theme and guide students toward the development of at least part of the project. The central project is, in effect, made up of component projects which are brought together to form a saleable product.

The central project at McCullough High School started when second year architecture students, tired of drawing typical residential and commercial buildings, wanted to try something different. Thus was born Project Space Station and its problem description of the need to research, design, and build a habitat which would sustain four people in an outerspace simulation for 72 hours. A few days after the announcement of the project, second-year technical drawing students

asked how they could become involved. It was decided that the Space Station needed an Orbital Maneuvering Vehicle (OMV) with mechanical or robotic arms to launch satellites and do repairs so the technical drafting class assumed the responsibility of designing and building it. The technical drafting students, in turn, began to work with the metal technology students who helped to develop and produce components for the OMV and its arms. Wood technology students then became involved in the project by developing and producing containers to hold experiments, food, and clothing. They also produced plaques which were presented to major contributors. Eventually almost every student enrolled in a technology course became involved in the project as a variety of components projects evolved. Figure 1 lists component and subcomponent projects which evolved to respond to the needs of the Space Station.

As the project grew, technology teachers realized not only that students from other courses could get involved, but that the talents of these students and their teachers were needed. As a result, some departments integrated the Space Station into their curriculum by developing, submitting, and monitoring experiments which the crew performed during the mission. For example, food services students researched space food and then precooked and packaged all of the meals for the astronauts. Art department students decorated the common areas of the space station with creative space art. Students in the math classes assisted with water volume, air replacement, and weight calculations and also prepared an experiment determining astronauts' response time during a mission. Physics students helped build robotic arms; language arts students prepared the astronauts for all of the

Figure 1
McCullough High School Central Project



writing that would be required; and social studies classes took an active part in soliciting support and participation from local, state, and national elected officials.

News of the project traveled to the community and garnered the support of individuals and companies who pitched in by donating time, money, materials, and expertise. A physician in the community who had worked for NASA during the Apollo mission invited some technology education students to his laboratory so he could show them the proper way to conduct the experiments.

The space station was set up and the mission carried out on the stage in the commons area of the school for everyone to see. At the blast-off celebration (pep rally), the entire school body and many

family and community supporters packed the gymnasium as the McCSA students entered like the football team and sat in the seats of honor.

The final night of the mission, a Space Station Extravaganza was held to give people in the community an opportunity to see the mission in progress. The school jazz band and choir performed to open the event. The crew performed experiments as the crowd watched by video camera and then launched a satellite (a helium balloon) with a message written for the occasion by elementary school children.

The Space Station project is an example of the integration of the practical application of science, mathematics, and language--technology education. It is also an example of a practical approach to implementing technology education. Traditional equipment does not have to be discarded and new "high tech" equipment purchased before such a project can be implemented. Such a project does require, however, a change in philosophy. A well-planned central project provides one of the best ways to make technology education a vital part of a school which helps students to learn how to learn.

Summary

During the past 10 years, the field of industrial arts, stimulated by rapid technological changes, has changed its name and its focus to technology education. During this soul-searching period, the profession has made a disciplined inquiry into the philosophy and purpose of education as a whole and industrial arts/technology education in particular.

Industrial arts goals chronicled from the 1920s to the present indicate an increased emphasis on the study of industry and

technology, critical consumerism, and the development of intellectual processes and interpersonal behavioral skills. A study of these changes by 20-year increments reveals how the discipline has changed from one which emphasized problem solving for a particular project to one which requires the application of problem-solving skills to global situations.

There are some who would argue that industrial arts/technology education is a paradigm in crisis because of a lack of understanding of the underlying philosophical differences between industrial arts and technology education. Clark (1989) makes a strong case for a new paradigm for technology education based on changes in subject matter, beliefs, values, methods, exemplars, and social matrices.

Aside from name changes, which may be superficial, new curriculum may be the best indicator of a true transition from an industrial arts to a technology education discipline. While there is still considerable disagreement among teachers, teacher educators, and technologists regarding what should be the content of technology education programs; a great number of content designs expand on the four technical systems of communication, transportation, manufacturing, and construction identified in the Jackson's Mill Industrial Arts Curriculum Theory document (Snyder and Hales, 1981). This document had a far-reaching influence on curriculum revision in the 1980s and is likely to influence future development for some time.

The field is not without exemplary programs which have gained the national spotlight. Some of these exemplary programs are statewide (New York, Virginia, Illinois); some are limited to specific areas within a state (metro Nashville, Tennessee; selected middle

schools in Georgia); and some are school specific (McCullough High School in Conroe, Texas). The best programs are those in which problem-solving and critical thinking experiences are provided for the students. The research cautions practitioners to beware of model programs which highlight the content to be taught or the "high" technology to be used rather than the method of instruction. Technologically literate students are those who can solve problems that they have identified, develop methods for study, and evaluate alternatives in systematic fashion--good technology education programs should reflect these outcomes.

For industrial arts/technology education instructors, this is an exciting time of change and growth. However, it is also a period which requires renewed professional commitment and dedication to insure that industrial arts/technology education takes its rightful place in the school curriculum.

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